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ABSTRACT

Commercial, sport, and personal-use and subsistence fishers share the salmon harvest on the Copper River, Alaska. The allocation of salmon among these user groups is a contentious and recurring issue. Economic analyses, along with biological, legal, social and cultural considerations, have the potential to help policy makers appreciate the consequences of alternative allocations. The zonal travel cost method is used to estimate the net economic value (consumer surplus) of the Copper River Basin personal-use and subsistence fisheries. The nature of the fishery and the data set is especially well suited for this purpose.

Key words: zonal travel cost model, subsistence/personal-use harvests

THE ECONOMIC VALUE OF ALASKA'S COPPER RIVER PERSONAL-USE AND SUBSISTENCE FISHERIES

Introduction[1]

Alaska's Copper River is a high-energy glacial system that flows south from headwaters in the Wrangell Mountain Range to the entrance to Prince William Sound. The wild game and fish stocks of the Copper River Basin have supported human populations for millennia. Although many changes have taken place, these fish stocks remain important to the livelihood and lifestyle of many Alaskans. The annual harvest of Copper River salmon averages 1.6 million fish, shared among commercial, sport, subsistence, and personal-use fishers. Catches are primarily chinook (*Oncorhynchus tshawytscha*), sockeye (*O. nerka*), and coho (*O. kisutch*) salmon. Chinook average 24 lbs., coho, 9.4 lbs., and sockeye, 5.7 lbs.

The commercial fishery is comprised of 505 limited entry permit holders[2] who fish drift gillnets off the river's mouth near Cordova, Alaska. Commercial fishers typically harvest in excess of 90-95% of the permitted harvest level for Copper River origin salmon, concentrating their effort on the June-July mixed run of sockeye and chinook (ADF&G, 1996b). The gross ex-vessel value of landings is about $8 million per year.

The sport fishery targets chinook in the Copper River's clear-water tributaries, most notably the Gulkana and Klutina rivers. Approximately 30,000 anglers participated in the sport fishery during 1996 and harvested approximately 3% of the chinook catch (ADF&G, 1996b). The sport fishery is open to resident and non-resident license holders, subject to season, geographic, gear and bag restrictions.

The personal-use and subsistence fisheries allow participants to harvest fish for personal consumption and traditional exchanges. These fisheries are open from June 1 to September 30 and take place along a 10-mile stretch of the Copper River near Chitina, Alaska. During the first twelve weeks of the season, sockeye comprise 97% of the harvest and chinook comprise the remaining 3%. During the last five weeks of the season, the harvest is 63% sockeye and 37% coho. Participation in the personal-use and subsistence fisheries is restricted to Alaska residents who possess a resident sportfishing license ($15) and pay an annual access fee ($10). The access fee is the result of an agreement between Ahtna and Chitina Native Corporations and the State which allows personal-use and subsistence fishers to trespass on native land holdings. The State of Alaska transfers all access fee receipts to the Ahtna and Chitina corporations.

Rules governing eligibility for participation in the personal-use and subsistence fisheries have changed over time and can be expected to continue to evolve due, in part, to the expansion of Federal authority pursuant to the Ninth Circuit Court's decision in Katie John v. Alaska (Native American Rights Fund, 1995), and the likely federal assumption of management authority under ANCSA (PL 92-203 1971). Federal regulations stipulate a zip code based eligibility system for subsistence that excludes urban (the Anchorage-Matanuska, Fairbanks, Kenai Peninsula, and Juneau) residents. Changes can be expected to affect the year 2000 fishing season, whether the State relinquishes control to the Federal government or new State regulations are adopted.

Personal-use and subsistence permits are issued to individuals or families for fishwheels or dip nets.[3] Although neither fishery is restricted to one gear type, most subsistence fishers use fishwheels while the majority of personal-use fishers use dip nets. While personal-use season bag-limits vary according to run-strength, individuals and families have usually been allocated

15 and 30 fish, respectively. These bag limits include a maximum of five chinook salmon (ADF&G, 1996a). Although subsistence fishers may request bag limits up to 200 and 500 for individuals and families, respectively, the standard bag limit is 30 fish per individual, 60 per two-member family, and 10 more salmon for every additional family member. (Family may be defined as an entire village or extended family.) Approximately 7,000 personal use and 800 subsistence permits are issued each year (15% to individuals and 85% to families). Subsistence and personal-use fishers harvested 2% and 4% of the 1996 salmon harvest, respectively (ADF&G, 1996b).

The Alaska Board of Fisheries is responsible for allocation decisions. Allocation of catch among competing user-groups is among the most contentious and perennial management issues faced by the Board. In making allocation decisions, the Board is required to ensure that spawning escapements are sufficient to support maximum sustained yields. Returning salmon in excess of escapement objectives are available for harvest. Alaska's constitution and federal law identify subsistence as the highest priority extractive use. Thus commercial and sport fisheries are permitted when managers anticipate that escapement targets and subsistence needs will be satisfied. However, the sequential character of the fishery coupled with the need to prosecute of the commercial fishery in marine waters before the run strength can be fully assessed can lead to an unintended reallocation of fish from subsistence, personal-use, and sport fishers to the commercial fishery (Criddle, 1996).

Although there have been economic analyses of the commercial fishery, (e.g., Herrmann and Greenberg, 1994, and Boyce et al., 1993), and the sport fishery (Layman et al., 1996), there are no comparable studies of the personal-use and subsistence fisheries. We attempt to address this lack by developing estimates of the consumer surplus per household permit holder for the personal-use and subsistence fisheries.

Data

Personal-Use and Subsistence Permits—ADF&G maintains a time series-panel database constructed from information submitted on the personal-use and subsistence permit applications and reports. This database includes records for each subsistence and personal-use trip completed between 1988 and the present (over 100,000 records). Personal-use and subsistence fishers are required to record the date of their trip(s) as well as the number and type of fish caught on their permit. In addition to reported catch, each permit contains information that can be used to identify their place of residence and to track participation through time. Table 1 contains a descriptive summary of these variables.

Model

We used a zonal travel cost model (TCM) adjusted for unequal zones following Strong (1983). Our choice of TCM was motivated by two reasons. First, the existing data included all of the information needed for estimation of a TCM model whereas the information requirements for other valuation methods would have necessitated the administration of an additional survey instrument. Second, many participants in the personal-use fishery and most participants in the subsistence fishery reside in communities with mixed economies and have a limited frame of reference for valuing food items, which are usually acquired through individual or group harvest activity or through gifting or exchange for other nonmarketed foods and products. Implementing the zonal TCM requires organizing the observations into visits from mutually exclusive zones. Because participants from each zone are assumed to be homogenous, the zones must be constructed such that participants share similar income and demographic characteristics as well as similar travel costs.

Zones—Participants in the Chitina personal-use and subsistence fishery travel from throughout the State with one way distances ranging from 0.5 to 1,494 miles. Most participants live in Copper River Basin communities (Chitina, Glennallen, Gulkana, and Copper Center), South-Central communities (Anchorage, Eagle River, Wasilla, and Palmer), the Kenai Peninsula region (Homer, Seward, Soldotna, and Kenai), and the Interior (Cantwell, Delta Junction, Fairbanks, North Pole, Nenana, and Healy). However, a few individuals travel from the Southeast region (Juneau, Ketchikan, Sitka, and Wrangell), and the Arctic region (Kotzebue, Nome, Barrow, and Deadhorse). Table 2 summarizes the range of variability in travel distances and demographic characteristics.

The most direct route from each community was used to determine the distance traveled. Trips by residents of communities that are not road accessible (less than 1% of the 1980-1998 trips) were omitted. Participants from these communities incur substantial air-travel costs. Consequently, it is likely that these trips are multipurpose.

U.S. Department of Commerce (1991) provides median household income by zip code for 1990. This income is reported as a before tax income, hence, all income was adjusted by average Alaskan tax liability by income bracket. There is no other consistent source of information on median household income data for Alaska; hence, this research focuses only on the 1990 permit trip data.

The distance and travel route from the community to the fishery, and the 1990 median household income were used to determine seventy-five zones. One-way travel distance for communities within zones differ by no more than 40 miles. Within-zone variation in median incomes differs by 14%, at most.

Variable Construction—Although the permit database provides much of the information needed to implement the zonal TCM, the visitation rate and the travel cost variables were not directly observed, but were instead constructed from secondary sources. The visitation rate VR_i is defined as the ratio of trips to households in zone *i*. The travel cost TC_i is defined as the sum of site fees, the travel distance cost (the product of distance and cost per mile), and time cost (the product of travel time and the opportunity cost of time) from zone i. Median household income was used as a proxy for the wage rate.

The 1990 Census database provided populations as well as the number of individual and family households by zip code. We chose to define visitation rates by households because the permits are issued on a household basis and the database does not provide the number of individuals who fished the permit per trip. Because Chitina is near the end of a road that terminates in the Wrangell mountains and is not on any direct route between major population centers, it was assumed that household trips to fish the Copper River are single purposed and that only one permit is fished for each trip to Chitina. This assumption ignores the possibility that some participants might have carpooled on some trips and creates a downward bias in the visitation rate estimates. Because catches are supposed to be reported on a single line on the permit per trip, we assumed that each date with recorded catches represented a separate trip. However, some individuals may have recorded their daily catches on separate lines. Consequently, some multiday trips may have been misconstrued as multiple trips, leading to an upward bias in the visitation rate estimates.

Travel Costs—The travel distance cost was computed as the product of the round trip distance from each zone to Chitina and the cost per mile. We used two different values for cost per mile. One could argue that the cost of operating a vehicle should include vehicle wear (i.e., oil, tires, etc.) as well as the cost of gasoline. However, individuals may make vehicle travel cost decisions based on the cost of gasoline alone. The estimated gasoline cost per mile for 1990 was $0.07.[4] We used the State of Alaska employee-use-of-personal-vehicle-for official-business reimbursement rate of $0.31 per mile as a proxy for the total cost of vehicle operation. The cost related to travel time was approximated as the product of the round trip time from each zone Chitina and the shadow value of time, derived as a fraction of the average wage rate of residents in that zone. The time spent traveling was estimated from the minimum distance route, assuming an average speed of 55 mph, the posted speed limit on most sections of the approach routes.

Previous studies have recognized that the time spent traveling to a site should be included as a component of travel cost for purposes of estimating the demand for visits (Cesario and Knetsch, 1970 and Knetsch, 1963). The choice of opportunity cost of time affects estimates of the elasticity of demand and total value of the site. With a higher opportunity cost of time, the predicted reduction in the number of visits is smaller, and the estimated demand curve is less elastic. If it is assumed that individuals are free to choose the number of hours worked at a given wage rate, the opportunity cost of time equals the wage rate. However, the appropriate opportunity cost of time depends on the alternative uses to which the time could be put and on the nature of the constraints on individual choice (Shaw, 1992). Cesario and Knetsch (1970) maintain that the opportunity cost of time falls between 25% and 50% of the wage rate. Cesario (1976) concluded that the scarcity value of time was approximately one-third of the average wage rate. McConnell and Strand (1981) found 60% of the wage rate provided the best fit. The range for wage rate adjustment is generally suggested to be between 25% and 60% of the wage rate with the usual value adopted as 33% (Smith and Kaoru, 1990). This research uses 30% and 60% of the wage rate to value the opportunity cost of time because these values are similar to those assumed in other studies and they allow direct comparisons with the Copper River sport fishery study by Layman et al. (1996). Annual median income was divided by 2,000 hrs/year to approximate the average hourly wage rate.

The $10 annual access fee was converted into a zone-specific per trip cost by dividing the access fee by the average number of trips per permit from that zone.

Substitute Sites—Failure to consider substitute sites biases coefficient estimates and inflates the value of consumer surplus per visit estimates (Smith and Kaoru, 1990). Although there are other personal-use and subsistence fisheries, few are close substitutes for those of the Copper River. The only reasonable substitute is the Upper Cook Inlet personal-use fishery near the mouth of the Kenai River. This site is a road accessible dip net fishery with bag limits similar to the Chitina fisheries and is open from July 10 to August 5. Travel costs to the Kenai River dip net area were computed similarly to those to the Copper River.

Demographic Variables—The inclusion of variables related to demographic characteristics may reduce the variance of model residuals and lead to more robust estimates of consumer surplus (Bockstael and Strand, 1987). In addition to travel costs, the model considered the percent of males per zone, the percent of Alaskan Natives per zone, and the median age per zone. Unemployment rates and the percentage of residents receiving public assistance within the communities of each zone may also provide additional explanation for differences in visitation rates. Due to the federal guidelines for subsistence, rural designation is of primary importance to the fishery and is included as an explanatory variable. Annual unemployment rates, the percentage of communities with rural designation and the percent of community residents receiving public assistance were obtained at the zip code level from the 1990 Census.

The number of subsistence permits fished per zone was inversely related to travel distance. The ten zones within 200 miles of Chitina accounted for 91% of all subsistence trips taken in 1990. In seven of these zones, more than 90% of all trips were subsistence trips (Gakona, Mentasa, Chickaloon and Northway, were 100% subsistence). In contrast, participation from other regions (Sutton, Delta Junction, Houston, Wasilla, Anchorage, Talkeetna, North Pole, Chicken, Healy, Anderson, Nenana, Seward, and the Kenai Peninsula) was strictly personal-use. In order to identify influences of permit type composition (i.e., personal-use and subsistence) across zones on visitation rate, a variable representing the percentage of subsistence trips for each zone was established from the database.

Results

Previous applications of zonal TCM have adopted linear, semi-log and double-log specifications (e.g., Adamowicz et al., 1989; McConnell, 1985; Smith, 1988; Strong, 1983;and, Ziemer, Musser and Hill, 1980). We examined linear and semi-log model specifications. The model can be represented as

$$VR_i = f\begin{pmatrix} TC_i, KTC_i, Rural_i, PublicAssistance_i, \\ Unemployed_i, Native_i, Gender_i, Age_i, Subsistence_i \end{pmatrix}.$$

Where VR_i, the visitation rate, is the number of trips from each zone divided by total number of households in that zone; TC_i and KTC_i are the travel costs incurred during trips from zone i to Chitina or the substitute site, respectively. *Native* and *Rural* are respectively, the percent Alaskan Natives and the percent of residents that meet federal subsistence eligibility criteria. *Unemployed* and *PublicAssistance* are the annual unemployment rate and percent of population on public assistance in each zone. *Gender* is the percent of males, *Age* is the median age of residents by zone. And, *Subsistence* is the percent of subsistence permit trips taken from zone *i*.

Model specification was based on travel costs computed at the mid point between the upper and lower bound estimates ($0.19 per mile) and 30% of the wage rate for the opportunity cost of time.

Linear Model—The linear model was estimated using Ordinary Least Squares on 47 non-zero visitation rate observations (there was no participation from 28 of the 75 zones in 1990). The estimated coefficients on the travel cost and substitute travel cost had the expected signs, however, they were not significant at the 95% confidence level and there was significant evidence of heteroskedasticity.

Semi-log Model—The semi-log model coefficient estimates for *TC* and *KTC* were significant at the 95% level with the expected sign. There was no significant evidence of heteroskedasticity. The coefficient on *Unemployed* was positive and significant at the 95% confidence. The coefficient on *PublicAssistance* was negative and significant at the 90% level. Coefficients on *Rural*, *Subsistence*, *Native*, *Gender*, and *Age* were not statistically significant. Because *Native*, *Gender*, and *Age* are only available at a borough/census area level, the insignificance of these coefficients in a model constructed from zip code level visitation rates is not surprising. Consequently, these variables were dropped and the model was re-estimated. (*Rural* and *Subsistence* were retained due to the importance of these variables to the personal-use and subsistence permitting system.) A partial F-test indicated that there was no significant difference between the full and restricted model specifications.

Having specified functional form and the set of explanatory variables using travel costs computed with \$0.19 per mile and 30% of the wage rate for the opportunity cost of time, the restricted model was rerun using all four combinations of cost-per-mile and opportunity cost of time. Table 4 displays the results for the four restricted models with the t-statistics reported in parentheses. The coefficients on *TC* and *KTC* were significant at the 95% confidence level with the expected sign in all models. The estimated coefficients on *Unemployed* were positive and significant at the 95% confidence level in all models. *PublicAssistance* was significant at the 95% confidence level in all models except *LOWER60* for which it was significant at the 90% confidence level. The coefficients on *Rural* and *Subsistence* were uniformly insignificant.

Consumer Surplus Estimates—The area under the demand curve is the measure of the value of the site/activity. However, the demand curve is estimated from a statistical model in which random errors are associated with estimated parameters. This leads to random welfare measures. Smith (1990) suggests that estimators be selected on the basis of statistical properties of the welfare estimates rather than statistical properties of the demand function parameters, when the purpose of statistical estimation of demand functions is derivation of welfare measures.

Consumer surplus would reflect the average benefit per person if a per capita travel costs were established, however, the travel costs used in this research is a household permit trip cost. Therefore, consumer surplus is the value of the use of household permits. Estimating different models for individual households and family households would have been more appropriate, however, the income data available does not provide income by family households and households of one. Hence, consumer surplus divided by total number of household permits will yield average benefit per household.

Each of the models was used to derive consumer surplus estimates because they span the range of likely parameter specifications. Following Smith (1990), consumer surplus was estimated as

$$CS = \sum_{i=1}^{75}\left[\frac{Households_i}{\hat{\beta}_1}\exp\begin{pmatrix}\hat{\beta}_0 + \hat{\beta}_2(KTC_i) + \hat{\beta}_3(Rural_i) \\ +\hat{\beta}_4(PublicAssistance_i) \\ +\hat{\beta}_5(Unemployed_i) + \hat{\beta}_6(Subsistence_i)\end{pmatrix}\left(\exp(\hat{\beta}_1 P^*) - \exp(\hat{\beta}_1 TC_i)\right)\right],$$

where $Households_i$ is the total number of households in zone i and P^* is the choke price estimated from each demand equation. Table 5 reports the four consumer surplus estimates.

The total consumer surplus estimates range from \$146,366 to \$481,012 depending on values used for cost per mile and the opportunity cost of time. This value is in addition to the price (travel cost) individuals paid to participate in the fisheries. Dividing consumer surplus by the number of 1990 permits (5,979) provides the average value of a personal-use/subsistence permit to a household. Values per permit for a household range from \$24.48 to \$80.45.

Confidence intervals were estimated using the simulation method suggested by Krinsky and Robb (1986). The simulation generates parameters with the same mean and variance as the estimated parameters. These generated parameters are then used to compute consumer surplus. The simulation performed for this research generated 2,000 sets of parameters, which led to 2,000 consumer surplus estimates. These estimates provided 95% confidence intervals presented in Figure 1 and in Table 6. At the simulated 95% confidence level, the lower bound of consumer surplus ranges from \$96,248 to \$323,003 and the upper bound ranges from \$324,358 to \$1,170,749 depending on the value for the opportunity cost of time and the cost per mile used.

Conclusions

Nearly 6,000 households participated in the personal-use and subsistence fisheries in 1990 harvesting approximately 6% of all salmon harvested in the Copper River Basin. Estimates of consumer surplus per trip ranged from $17.31 to $56.88 depending on the assumed travel costs and opportunity cost of time. These values compare favorably with those reported by Layman et al. (1996) for the Gulkana River sport fishery. They report per-trip consumer surplus estimates for sport fishing on the Gulkana River of $26.05 to $32.35 for models that incorporate vehicle operation costs and approximate the opportunity cost of time at 30% and 60% of the wage rate, respectively. Adjusting those estimates to the 1996 base used in this study, the estimates of consumer surplus per sport fishing trip are $28.55 and $35.46. The estimates of consumer surplus per personal-use/subsistence trip also compare favorably with a lower-bound estimate of the replacement cost of the personal-use/subsistence catches. Using the exvessel sales price as a lower-bound estimate of cost per pound multiplying by the average weight per fish and mean catch per trip and adjusting to 1996 values, the per-trip cost of replacing personal-use/subsistence catches equals $98.09.[5]

It would be of interest to estimate separate values for the personal–use and subsistence fisheries. However, separate visitation rates are not possible since the population of households per zone that qualify for each of the fisheries is not known. Because the composition of the salmon run varies over the season, separate visitation rate models for the early season (first 12 weeks) and late season (last 5 weeks) would also be interesting. Perhaps most interesting of all would be development of a modeling framework that would allow fuller use of the richness of information about individual/household participation through time.

Footnotes

1. The authors are with, respectively, Northern Economics, Anchorage, AK; Resource Ecology and Fisheries Management Division, Alaska Fishery Science Center, National Marine Fisheries Service, Seattle, WA; and Department of Economics, Utah State University. This paper is the result of research supported in part by Alaska Sea Grant with funds provided by the National Oceanic and Atmospheric Administration Office of Sea Grant, under grant NA90AA-D-SG066, project R32-01.

2. Alaska's commercial salmon fisheries have been managed under a limited access system since 1976. Limited entry permits are transferable use privileges that are specific to region and gear type.

3. Fishwheels are large (8-12ft radius) devices that consist of two to four large (6-8ft wide by 2-4ft tall by 2-3ft deep) wire baskets attached to the spokes of an axle. The wheels are anchored in the river near the bank such that the baskets are alternately immersed as the force of the current spins the wheel. Upstream migrating fish are entrapped as the by the baskets as they sweep through the water and tumbled into a bin or pen as the basket rises through the air. Dip nets are long (12-24ft) rigid poles with bag-shaped nets (2-5ft diameter). Dip nets are used to fish from a riverbank or from drifting boats.

4. ($1.20 per gallon)/(18 mpg) = $0.07 per mile.

5. ($1.60/lb)(24 lbs./chinook)(0.229 chinook/trip) + ($1.30/lb)(5.7 lbs./sockeye)(11.756 sockeye/trip) + ($0.50/lb)(9.4 lbs./coho)(0.465 coho/trip)

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Table 1—Statistical summary of variables included in the ADF&G Copper River basin fishery database.

Variable	Median	Mean	Std. Dev.	Minimum	Maximum
Family size per permit	3	2.984	1.624	0	72
Number of trips per permit	1	1.5	0.869	1	5
Number of Sockeye per trip	6	11.756	17.446	0	493
Number of Coho per trip	0	0.465	1.281	0	85
Number of Chinook per trip	0	0.229	1.985	0	99
Number of Steelhead per trip	0	0.003	0.092	0	9
Number of other fish per trip	0	0.01	0.243	0	18
Total number of fish per trip	7	12.463	17.844	0	501

Table 2—Summary Statistics

Variable	Mean	Std Dev	Minimum	Maximum
Distance to Chitina	380.63	306.18	.50	1,494.00
Travel Time to Chitina	10.70	10.91	.02	43.20
Median Household Income	25,045.26	3,944.87	16,733.97	35,413.07
Community Population	5,585.67	12,983.60	25	75,819
Total Number of Households	1,345.81	2,198.64	1	8,603
Summer Unemployment Rate	0.03	0.01	0	0.05
Annual Unemployment Rate	0.18	0.14	0	1
Median Age	29.87	1.66	26.4	34.20
Percent of Population that is Alaskan Native	0.16	0.19	0.05	0.73
Percent of Population that is Male	0.59	0.13	0.51	0.90
Percent of Population on Public Assistance	0.10	0.09	0.00	0.37

Table 3—Models Resulting from Varying Cost Per Mile and Percent of Wage Rate to Compute Travel Cost

Model	Travel Cost per mile	Mean Travel Cost	Std. Dev.	Minimum	Maximum
LOWER30	$0.07	$133.44	$110.81	$4.99	$515.74
UPPER30	$0.31	$309.76	$252.38	$5.23	$1,121.06
LOWER60	$0.07	$208.00	$181.44	$5.15	$873.03
UPPER60	$0.31	$384.31	$320.38	$5.39	$1,399.11

Table 4—Restricted 1990 Model Linear Regression Output

Model	*UPPER30*	*LOWER 30*	*UPPER60*	*LOWER 60*
Intercept	-3.874*	-3.736*	-3.840*	-3.911*
	(-5.241)	(-5.363)	(-5.367)	(-5.759)
TC	-0.007*	-0.021*	-0.006*	-0.013*
	(-2.976)	(-3.559)	(-3.246)	(-3.465)
KTC	0.005*	0.013*	0.004*	0.008*
	(2.314)	(2.901)	(2.603)	(2.804)
Rural	0.361	0.492	0.384	0.593
	(0.467)	(0.676)	(0.510)	(0.818)
PA	-11.412*	-10.009*	-10.878*	-9.611**
	(-2.205)	(-2.017)	(-2.145)	(-1.925)
UNEM	8.799*	9.042*	8.881*	9.484*
	(2.100)	(2.268)	(2.168)	(2.337)
Sub	0.014	0.009	0.012	0.009
	(1.535)	(0.983)	(1.293)	(0.962)
Adjusted R^2	0.382	0.429	0.403	0.422
RMSE	1.949	1.874	1.915	1.884
N	47	47	47	47
df	40	40	40	40

* significant at the 95% confidence level ** significant at the 90% confidence level

Table 5—Consumer Surplus Estimates

Model	Total Consumer Surplus	Consumer Surplus Per Household Permit (5,979)	Consumer Surplus Per Trip (8,456)
LOWER30	$146,366	$24.48	$17.31
UPPER30	$430,655	$72.03	$50.93
LOWER60	$228,617	$38.24	$27.04
UPPER60	$481,012	$80.45	$56.88

Table 6—K-R Simulation Consumer Surplus Confidence Interval Estimates

	K- R Median CS	95% CI lower bound	95% CI upper bound
LOWER30	$169,862	$96,248	$324,358
UPPER30	$516,851	$286,553	$1,106,294
LOWER60	$270,507	$159,297	$516,817
UPPER60	$578,426	$323,003	$1,170,749

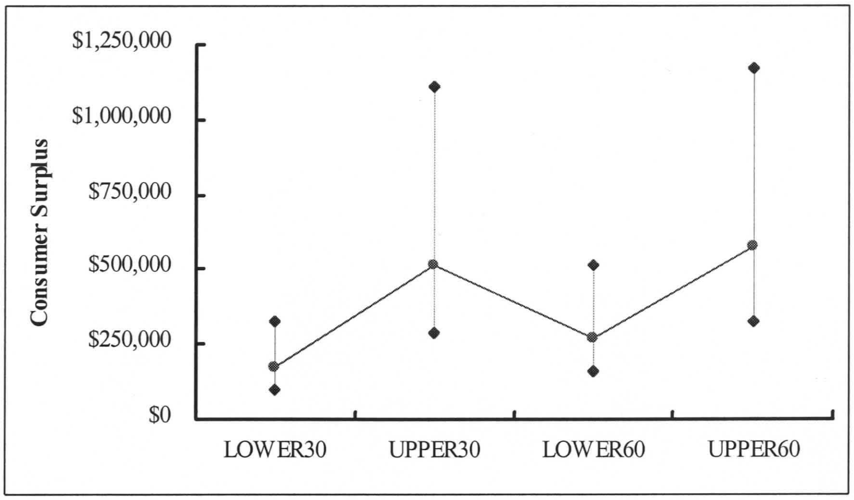

FIGURE 1—Estimates of median consumer surplus with 95% confidence intervals.